The University of Iowa
Department of Civil & Environmental Engineering
SOIL MECHANICS 53:030
Midterm Exam II
(1 Hour)

Fall 1999 Instructor: C.C. Swan

Problem #1: (35 points)

A light industrial park is to be built on the compacted fill shown below in Figure 1 which is to be placed over the existing layer of normally consolidated clay soil. The buildings and facilities in the proposed development can tolerate settlements of no more than 2 inches. Once the compacted fill is placed, how long must the developer wait to begin construction of the facility? (For simplicity, assume instantaneous placement of the fill, and that settlements due to buildings will be negligible.)

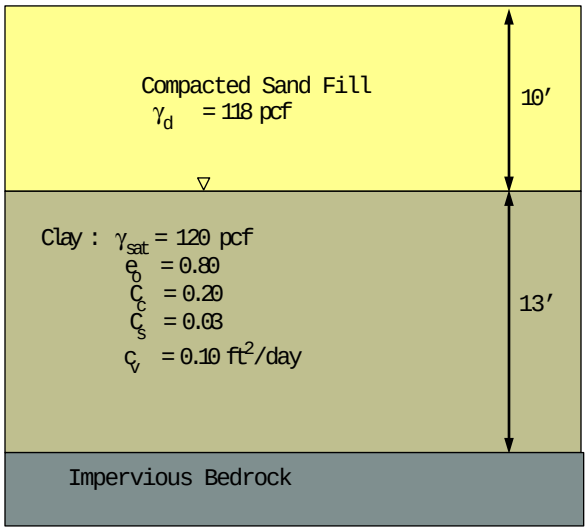

Figure 1. Soil profile for Problem #1.

Problem #2: (35 points)

A certain soil has a drained cohesion c = 12 kPa, and ϕ_D = 32°. At a point in the soil, the major and minor principal stresses are 348 kPa and 160 kPa, respectively, and the pore pressure is 96 kPa.

a. Show that shear failure should occur at this point.

b. Using the Pole Method, determine the angle between the major principal plane and the plane on which shear failure occurs. (Show all work to receive credit.)

c. Compute the effective stresses on the failure plane.

Problem #3: (30 points)

Consider the line load shown below in Figure 2. Using the formulas provided:

a. Compute the increased vertical ($\Delta\sigma_z$) and horizontal ($\Delta\sigma_x$) normal stresses, as well as the increased shear stress $\Delta\tau_{xz}$ at point M due to the applied load.

b. Neglecting the initial stresses in the soil, compute the maximum shear stress at point M due to the line load.

$$\Delta\sigma_z = \frac{2qz^3}{\pi(x^2+z^2)^2} \qquad \Delta\sigma_x = \frac{2qx^2z}{\pi(x^2+z^2)^2} \qquad \Delta\tau_{xz} = \frac{2qxz^2}{\pi(x^2+z^2)^2}$$

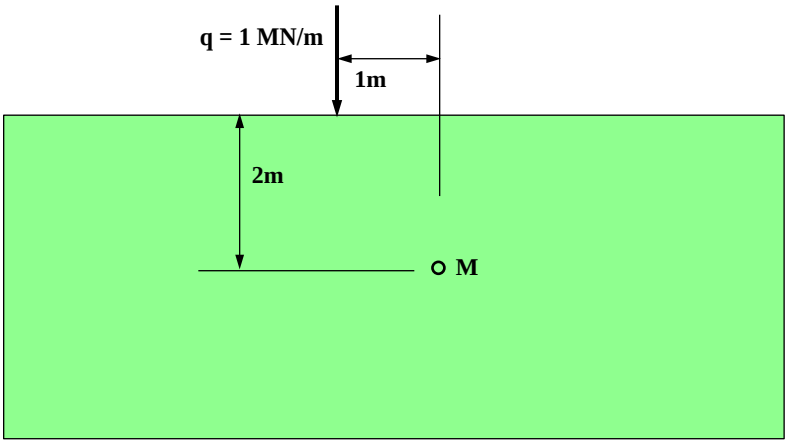

Figure 2. Soil profile for Problem #2.

Bonus Problem: (10 extra points!!!)

A grain silo, a very heavy structure, was recently built on a saturated clay soil deposit, and due to a short, intense harvest season, it was completely filled with grain in only a few days. The silo had never been loaded before, and the grain weighs about twice as much as the unloaded silo. The filled silo is exerting both compressive and shearing stresses on the underlying saturated clay deposit.

A civil engineering has raised the concern of a possible bearing (shear) failure in the soil beneath the silo. (This can and does sometimes happen.)

Given that the soil has not yet failed, and assuming that the weight of the filled silo remains unchanged, explain whether and why the risk of soil failure increases, decreases, or remains constant with the passage of time.